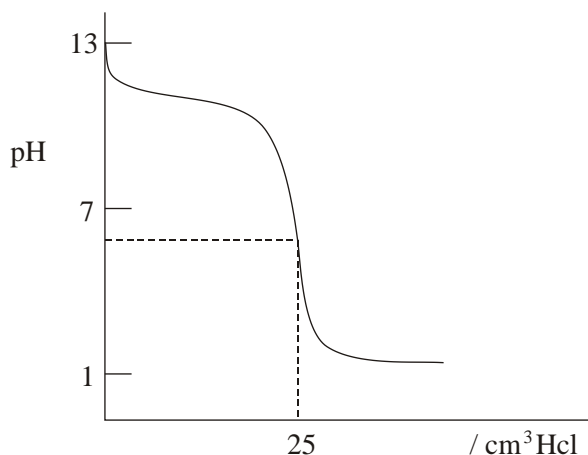


RT18 – HL 18.4-5 IB Review MS

1. C
2. A
3. B
4. D
5. (i)



graph starting at pH < 13;

Award [0] for pH=13.

equivalence point pH < 7;

Accept anything between 4 and 6

bottom end of graph: pH between 3 and 1;

NH₃ is a weak base/partially dissociated/[OH⁻] < 0.10 mol dm⁻³
(therefore, pH < 13);

NH₄⁺ formed is a weak acid/NH₄⁺ ⇌ NH₃ + H⁺/NH₄⁺ dissociates into
a weak base and a strong acid (thus acidic at equivalence point);

HCl is a strong acid, thus graph finishes close to pH = 1;

- (ii) methyl orange/bromocresol green/bromophenol blue/methyl red;
pK_a of indicator centered around pH at equivalence/end point/indicator
pH range falls where there is a sharp pH change/OWTTE;

6

2

[8]

6. (a) HIn(aq) ⇌ H⁺(aq) + In⁻(aq);
⇌ needed for mark. State symbols not essential.

1

- (b) (i) yellow as equilibrium shifts to left to remove (added) H⁺(aq);
Color and explanation needed for the mark.

1

- (ii) green/blue-yellow;
both HIn(aq) and In⁻(aq) are present;

2

[4]

7. (a) 2NH₃ + H₂SO₄ → (NH₄)₂SO₄

Accept correct equation with NH₄OH instead of NH₃.

mol H₂SO₄ = 0.0201 × 0.150;

2NH₃ = H₂SO₄/mol NH₃ = 6.03 × 10⁻³;

[NH₃] = 0.241 (mol dm⁻³);

4

Apply -1(SF) if appropriate.

Award [3] for the correct final answer for the concentration calculation.

- (b) bromocresol green;
reaction of weak base and strong acid/OWTTE;
pH range of bromocresol green is 3.8 to 5.4 / occurs at pH < 7;

3

(c) $K_b = 10^{-4.75} = 1.78 \times 10^{-5};$

$$K_b = \frac{[\text{NH}_4^+][\text{OH}^-]}{[\text{NH}_3]} / [\text{OH}^-] = \sqrt{K_b[\text{NH}_3]};$$

$$[\text{OH}^-] = \sqrt{1.78 \times 10^{-5} \times 0.121};$$

$$\text{pOH} = 2.83;$$

4

Award [4] for the correct final answer.

Allow ECF, for example any correct conversion of $[\text{OH}^-]$ to pOH.

[11]

8. (i) $\text{pH} = -\log[\text{H}^+];$
 (ii) curve should include the following:
 starting $\text{pH} = 1;$

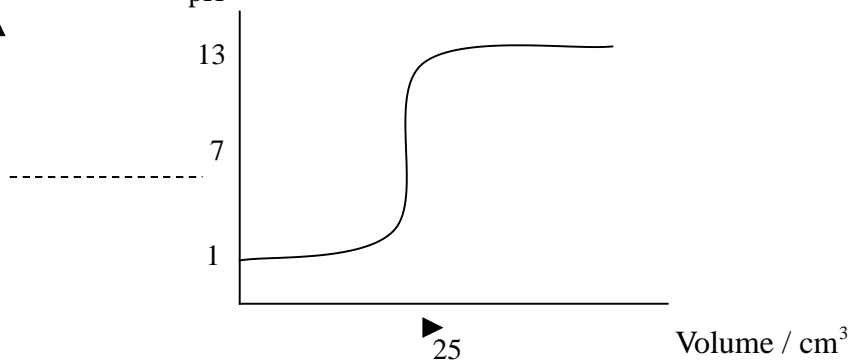
1

equivalence point: 25.0 cm^3 of NaOH;

pH at equivalence point = 7;

pH to finish = 12.3;

pH



4

Penalize [1] if profile incorrect.

(iii) $K_a = 10^{-4.76} / 1.74 \times 10^{-5};$

$$K_a = [\text{H}^+]^2 / [\text{CH}_3\text{COOH}] / 1.74 \times 10^{-5} = \frac{[\text{H}^+]^2}{0.100};$$

$$[\text{H}^+] = 1.32 \times 10^{-3} \text{ (mol dm}^{-3}\text{)};$$

starting $\text{pH} = 2.88;$

Accept 3 sig. fig.

Award [4] for correct pH.

Allow ECF.

pH at equivalence point: 8-9;

5

[10]